CLAIMS

What is claimed is:

1. A gas regulator comprising:

a slave valve assembly for receiving and controlling the flow of gas to a desired destination;

a timing chamber positioned adjacent to the slave valve assembly, the timing chamber having an inlet for also receiving the gas;

an electronically operated pilot valve assembly in communication with the timing chamber for operating the slave valve assembly, when the pilot valve assembly is closed, gas pressure within the timing chamber acting on the slave valve assembly closes the slave valve assembly, and when the pilot valve assembly is open, gas exits the timing chamber reducing the gas pressure in the timing chamber thereby allowing the slave valve assembly to open and deliver the gas to the desired destination.

2. The gas regulator of Claim 1 in which the slave valve assembly comprises a slave valve nozzle and a slave valve member for engaging the slave valve nozzle, the gas pressure within the timing chamber acting on the slave valve member controlling the operation of the slave valve member.

3. The gas regulator of Claim 2 in which the slave valve member is a diaphragm.

4. The gas regulator of Claim 3 in which the electronically operated pilot valve assembly includes a piezoelectric device.

5. The gas regulator of Claim 3 in which the electronically operated pilot valve assembly is a solenoid operated pilot valve assembly.

6. The gas regulator of Claim 5 in which the solenoid operated pilot valve assembly comprises:

a pilot valve nozzle;

a pilot valve member for engaging the pilot valve nozzle; and

a solenoid for operating the pilot valve member.

7. The gas regulator of Claim 6 in which the solenoid operated pilot valve assembly further comprises a spring for biasing the pilot valve member towards the pilot valve nozzle to be normally closed.

8. The gas regulator of Claim 7 in which the pilot valve nozzle and the pilot valve member are aligned along a common axis, whereby the pilot valve member moves along the axis for engaging and disengaging from the pilot valve nozzle.

9. The gas regulator of Claim 8 in which the slave valve assembly, the timing chamber and the solenoid operated pilot valve assembly are positioned within a common housing, the timing chamber and the pilot valve nozzle being connected by a passage therebetween.

10. The gas regulator of Claim 8 in which the slave and pilot valve nozzles each have an opening, the pilot valve nozzle opening being smaller than the slave valve nozzle opening for minimizing the solenoid size and energy expended by the solenoid.

11. The gas regulator of Claim 10 in which the slave and pilot valve nozzle openings are sized to provide at least about a 45:1 area and solenoid energy efficiency ratio.

12. The gas regulator of Claim 11 in which the slave valve nozzle opening is at least about .048 inches in diameter and the pilot valve nozzle opening is about .007 inches in diameter.

13. The gas regulator of Claim 1 in which the gas is oxygen for delivery to a patient.

14. The gas regulator of Claim 13 further comprising a sensing circuit for sensing inhalation by the patient for controlling the electronically operated pilot valve assembly.

15. A gas regulator comprising:

a housing;

a slave valve assembly positioned within the housing for receiving and controlling the flow of oxygen to a patient, the slave valve assembly having a slave valve nozzle and a slave valve member comprising a diaphragm for engaging the slave valve nozzle;

a timing chamber within the housing positioned adjacent to the slave valve member, the timing chamber having an inlet for also receiving the oxygen; and

a solenoid operated pilot valve assembly positioned within the housing and in communication with the timing chamber by a passage therebetween for operating the slave valve assembly, the solenoid operated pilot valve assembly comprising a pilot valve nozzle, a pilot valve member for engaging the pilot valve nozzle, a solenoid for operating the pilot valve member, and a spring for biasing the pilot valve member towards the pilot valve nozzle such that the pilot valve assembly is normally closed, and when the pilot valve assembly is closed, oxygen pressure within the timing chamber acting on the slave valve member closes the slave valve assembly, and when the pilot valve assembly is open, oxygen exits from the timing chamber reducing the oxygen pressure in the

timing chamber thereby allowing the slave valve assembly to open and deliver the oxygen to the patient, the slave and pilot valve nozzles each having an opening, the pilot valve nozzle opening being smaller than the slave valve nozzle opening for minimizing the solenoid size and energy expended by the solenoid.

16. The gas regulator of Claim 15 in which the pilot valve nozzle and the pilot valve member are aligned along a common axis, whereby the pilot valve member moves along the axis for engaging and disengaging from the pilot valve nozzle.

17. The gas regulator of Claim 16 in which the slave and pilot valve nozzle openings are sized to provide at least about a 45:1 area and solenoid energy efficiency ratio.

18. The gas regulator of Claim 17 in which the slave valve nozzle opening is at least about .048 inches in diameter and the pilot valve nozzle opening is about .007 inches in diameter.

19. The gas regulator of Claim 15 further comprising a sensing circuit for sensing inhalation by the patient for controlling the electronically operated pilot valve assembly.

20. A method of regulating with a gas regulator comprising:

receiving and controlling the flow of gas to a desired destination with a slave valve assembly;

positioning a timing chamber adjacent to the slave valve assembly, the timing chamber having an inlet for also receiving the gas;

operating the slave valve assembly with an electronically operated pilot valve assembly which is in communication with the timing chamber, when the

pilot valve assembly is closed, gas pressure within the timing chamber acting on the slave valve assembly closes the slave valve assembly, and when the pilot valve assembly is open, gas exits the timing chamber reducing the gas pressure in the timing chamber thereby allowing the slave valve assembly to open and deliver the gas to the desired destination.

21. The method of Claim 20 in which the slave valve assembly comprises a slave valve nozzle and a slave valve member for engaging the slave valve nozzle, the method further comprising controlling the operation of the slave valve member with the gas pressure acting on the slave valve member.

22. The method of Claim 21 further comprising forming the slave valve member from a diaphragm.

23. The method of Claim 22 further comprising providing the electronically operated pilot valve assembly with a piezoelectric device.

24. The method of Claim 22 further comprising forming the electronically operated pilot valve assembly as a solenoid operated pilot valve assembly.

25. The method of Claim 24 further comprising providing the solenoid operated pilot valve assembly with:

a pilot valve nozzle;

a pilot valve member for engaging the pilot valve nozzle; and

a solenoid for operating the pilot valve member.

26. The method of Claim 25 further comprising biasing the pilot valve member towards the pilot valve nozzle with a spring to be normally closed.

27. The method of Claim 26 further comprising aligning the pilot valve nozzle and the pilot valve member along a common axis, whereby the pilot valve member moves along the axis for engaging and disengaging from the pilot valve nozzle.

28. The method of Claim 27 further comprising positioning the slave valve assembly, the timing chamber and the solenoid operated pilot valve assembly within a common housing, the timing chamber and the pilot valve nozzle being connected by a passage therebetween.

29. The method of Claim 27 further comprising providing the slave and pilot valve nozzles each with an opening, the pilot valve nozzle opening being smaller than the slave valve nozzle opening for minimizing the solenoid size and energy expended by the solenoid.

30. The method of Claim 29 further comprising forming the slave and pilot valve nozzle openings to have sizes that provide at least about a 45:1 area and solenoid energy efficiency ratio.

31. The method of Claim 30 further comprising forming the slave valve nozzle opening to be at least about .048 inches in diameter and the pilot valve nozzle opening to be about .007 inches in diameter.

32. The method of Claim 20 further comprising delivering oxygen to a patient.

33. The method of Claim 32 further comprising sensing inhalation by the patient with a sensing circuit for controlling the electronically operated pilot valve assembly.

34. A method of regulating oxygen with a gas regulator comprising:

receiving and controlling the flow of oxygen to a patient with a slave valve assembly positioned within a housing, the slave valve assembly having a slave valve nozzle and a slave valve member comprising a diaphragm for engaging the slave valve nozzle;

positioning a timing chamber within the housing adjacent to the slave valve member, the timing chamber having an inlet for also receiving the oxygen; and

operating the slave valve assembly with a solenoid operated pilot valve assembly positioned within the housing and in communication with the timing chamber by a passage therebetween, the solenoid operated pilot valve assembly comprising a pilot valve nozzle, a pilot valve member for engaging the pilot valve nozzle, a solenoid for operating the pilot valve member, and a spring for biasing the pilot valve member towards the pilot valve nozzle such that the pilot valve assembly is normally closed, and when the pilot valve assembly is closed, oxygen pressure within the timing chamber acting on the slave valve member closes the slave valve assembly, and when the pilot valve assembly is open, oxygen exits from the timing chamber reducing the oxygen pressure in the timing chamber thereby allowing the slave valve assembly to open and deliver the oxygen to the patient, the slave and pilot valve nozzles each having an opening, the pilot valve nozzle opening being smaller than the slave valve nozzle opening for minimizing the solenoid size and energy expended by the solenoid.

35. The method of Claim 34 further comprising aligning the pilot valve nozzle and the pilot valve member along a common axis, whereby the pilot valve member moves along the axis for engaging and disengaging from the pilot valve nozzle.

36. The method of Claim 35 further comprising forming the slave and pilot valve nozzle openings to have sizes that provide at least about a 45:1 area and energy efficiency ratio.

37. The method of Claim 36 further comprising forming the slave valve nozzle opening to be at least about .048 inches in diameter and the pilot valve nozzle opening to be about .007 inches in diameter.

38. The method of Claim 34 further comprising sensing inhalation by the patient with a sensing circuit for controlling the electronically operated pilot valve assembly.